Brush powered Linear Motor

Field of the invention

The invention relates to the field of linear motors and more generally to linear motion closed loop control systems.

Background of the invention

Generally linear motors comprise an electromagnetic actuator and a linear position and motion sensor, together with a servo motion controller and its software and a power amplifier, they constitute a motion control servo loop that responds to an input command. The electromagnetic actuator can be of either the moving coil type or of the moving magnet type. The moving coil actuator basically comprises a stationary linear array of permanent magnets and a moving coils assembly, which needs an electrical connection to the stationary controller and power amplifier. The actuator of a moving magnet motor comprises a stationary array of coils wherein only the coil(s) adjacent to the magnet are energized at any time. This may be done by means of electronic power switches that switch on and off in accordance with the instantaneous position of the magnet assembly relative to the stationary coils. The switching (referred to as commutation) commands are generated based on the measured position of the magnet assembly as obtained by a position and motion sensor. Alternatively the commutation can be implemented by sliding contacts attached to the moving magnet array, such motor is described for example in US patent 459.5870. A moving magnet is not the subject of this invention and does not need a cable for powering of the moving magnet; the use of sliding contacts is mentioned only as a reference to the present invention

Conventional moving coil linear motors employ a flexible cable, or harness, to supply the actuating currents to the moving coils assembly. These currents are supplied by a stationary power amplifier, which is commanded by the motion controller, in accordance with the position of the moving coils assembly relative to the stationary magnets array which is supplied by a linear position sensor. In general, the use of a flexible power cable (- harness) has several disadvantages: it is cumbersome, it is expensive and its reliability is limited.

Prior attempts have been made to power the coils assembly without a cable connection, for example, in US patent 473.3143 the coils assembly is powered via brushes which are mounted on the coils assembly and are sliding on segmented rails that switch on and off the currents of the coils in the moving assembly, depending on its position. This method not only

obviates the power cable but also the need to switch the currents electronically. However, since the sliding contacts open and close periodically as the coil assembly moves, they deteriorate over time and additionally generate interfering noise due to arcing. In any case, such commutating brushes do not obviate the need for a harness that serves the position sensor, which is still needed for close loop operation.

Description of the figures

Figure 1 illustrates a block diagram of the linear motor of the present invention.

Brief description of the invention

The object of the present invention is to provide a moving coil type linear motor, which does not need a flexible cable to power the moving coils assembly. The moving coils assembly is energized by means of brush contacts sliding along continuous rails to provide continuous electrical contacts with no arcing. In the preferred embodiment of the invention the position sensor is also of a cable less type therefore no cable is needed.

Detailed description of the invention

It was found by the inventor that transferring power to a moving coil assembly in a moving coil type motor via continuous sliding contacts, rather than through segmented contacts as in prior art, provides reliable electrical contacts without the danger of arcing. The commutation is performed by electronic switches in a stationary amplifier, in conjunction with a controller - which receives information on the position of the coils assembly from a sensor – see **Figure 1**. In a preferred embodiment of the invention the position sensor is of a cable less type, i.e., it does not need its own flexible cable. The result is a moving coil assembly with no need for any flexible cable. Such cable less position and motion sensor is described in US patent applications 09/294749 and 138983.

Figure 1 illustrates a typical implementation of the invention in which the coils assembly includes three separate coils (- not shown) fed by three-phases A, B, and C. Accordingly there are three brushes fixed relative to the moving coils assembly, which are sliding on three stationary rails along the travel axis. In the preferred embodiment of the invention the power rails are made of printed circuit substrate with silver plated copper traces. The brushes are preferably made of carbon loaded with silver particles. In contrast with prior art the rails are not segmented and the sliding contacts are not interrupted as the coils assembly moves. Accordingly the sliding contacts do not arc do not generate noise that could interfere with the operation of the position and motion sensor, and are durable. The contacts thus establish continuous connection between the moving coils assembly and a stationary controller and

amplifier and from the standpoint of the controller and amplifier the coils are indistinguishable from conventional coils in a linear motor with flexible power cable. The invention thus does not need a special control hardware.